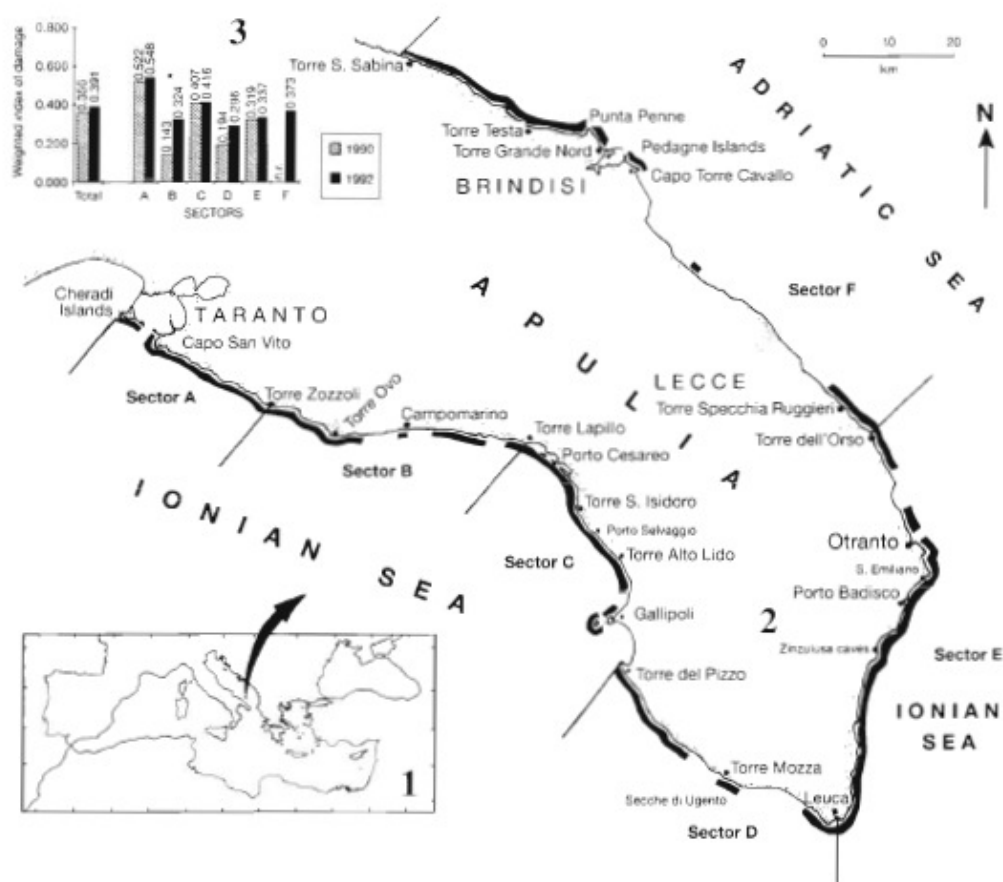


## Aim

Apulia is featured by a dramatic extension of barrens (Fanelli et al. 1994, Fig a) and, at the same time, of a general depletion of important fish stocks (Guidetti et al. 2005). The high density of sea urchins, preventing the recolonization of degraded rocky habitats, represents one of the most important drivers influencing pattern of distribution of assemblages of rocky substrates (Fraschetti et al. 2001; Guidetti 2003).



**Fig a** Map of the date mussel fishery impact along the Salento peninsula coast. For more details see Fanelli et al. 1994.

The Marine Protected Area of Porto Cesareo has been established in 1997. Notwithstanding the presence of two no-take no-man zones (the so-called A zone), the rocky substrate is still featured by an extensive barren caused by the date mussel fishery carried out in this area of Salento since decades. This area thus represents a natural experimental laboratory for the analyses of hypotheses about disturbed assemblages. Also, the oligotrophic conditions of the water column (Monitoring

Report Regione Puglia 2006) ensure the effectiveness of the experimental treatment represented by nutrient enrichment. Finally, the presence of a continuous monitoring linked to the presence of A Zone guarantees the protection of the experimental area from potential sources of vandalism.

The aim of this experimental study is to evaluate the combined effect of high concentrations of inorganic nutrients and high grazing pressure on the recovery pattern of subtidal rocky shores originally disturbed by the date mussel *Lithophaga lithophaga* fishery. Our question is how the two processes compare and combine in influencing trajectories of recovery of disturbed rocky substrates. We hypothesized a synergism between the two processes through the control operated by grazers on the opportunistic taxa facilitated by the experimental manipulated enriched conditions.

In the experiment we removed the sea urchins *Paracentrotus lividus* and *Arbacia lixula*, the most important herbivores present in this area, able to prevent the establishment and recruitment of propagules of any type of benthic organism and triggering a trophic cascade leading to the complete desertification of the substrate. The concentration of nutrients in the water column was experimentally increased using a special type of fertilizer (OSMOCOTE-PRO Controller Release Fertilizer 18-7-10, Scotts) largely used in the literature to recreate enriched conditions in the water column.

This is the first study on the effects of the two processes in the rocky subtidal in the Mediterranean Sea. It also represents one of the first attempts for the analysis of the interaction between processes operating at different spatial scales in the subtidal: grazing, acting primarily at small-scale, and nutrient enrichment, which is a process operating at large scale. The experiments using nutrient enrichment, even though difficult to put into practice, are an excellent approach to test ecological theories concerning the effects of nutrient availability on the composition of coastal assemblages and their development in time (Ceccherelli and Cinelli 1997; Worm et al. 2000; Bokn et al. 2003; Korpinen et al. 2007). These experiments can be used to predict the effects of coastal eutrophication, combining the advantages deriving by simulating real situations and allowing for an adequate replication, and problems (low accuracy in the quantification of enrichment in the context of experiments conducted at small spatial scale) (Worm et al. 2000).

We expect that significant differences between the treated areas in different response biological variables (percentage cover, number of taxa) will be observed. More

specifically, we can depict different scenarios on the base of the different combination of experimental treatments: in the plots where grazing pressure is removed, an initial growth of encrusting corallines and turf-forming algae will be possibly favoured. In the plots where grazing is removed and the availability of nutrients is experimentally increased, we expect an initial recovery phase featured by the settlement of opportunistic species typical of eutrophic environments (filamentous algae and turf-forming) able to monopolize the substrate, at low diversity. Finally, in areas where the two treatments enrichment and grazing are combined, we expect a faster growth of algal populations, together with a reduction of opportunistic species due to the presence of unmanipulated grazers. Grazers could, therefore, facilitate the subsequent settlement of species typical of macroalgal assemblages of subtidal rocky substrates, with composition and abundances strongly controlled by grazing pressure.

We anticipate that this study can provide important insights in pattern of recovery of disturbed assemblages crucial for the management of coastal marine habitats affected by multiple stressors, in absence of present strategies useful for implementing the restoration of coastal degraded habitats.